MONITORING POST-FLEDGING BURROWING OWLS IN SOUTHWESTERN IDAHO

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A western burrowing owl (*Speotyto cunicularia hypugaea*) equipped with a radio-transmitter package and colored leg bands

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PROJECT SUMMARY

Our study was designed to monitor the post-fledging behavior of burrowing owls (*Speotyto cunicularia*) in southwestern Idaho. During the 1994 breeding season, we captured and banded 71 burrowing owls. A subset of owls was fitted with radio-transmitters so that they could be tracked during the pre-fledging, post-fledging, dispersal, and pre-migratory periods. Nesting occurred during April, May and June. During this time, adult female burrowing owls incubated and brooded young, while adult males hunted, provided prey to the female and nestlings, and remained vigilant for predators. Nests were placed mainly in abandoned badger (*Taxidea taxus*) burrows. Nests were in areas dominated by cheatgrass brome (*Bromus tectorum*), tumble mustards (*Sisymbrium* spp.), and some big sagebrush (*Artemisia tridentata*). Burrow availability did not appear to be limited on the study area. Nests that successfully fledged young ($N = 8$) had lower vegetation surrounding them than those that were unsuccessful ($N = 6$), but the difference only approached significance. None of the other habitat parameters examined differed significantly between successful and unsuccessful nests, although the sample sizes based on our one-year study are probably too small to detect differences if they in fact existed.

Young burrowing owls appeared at the entrance to their natal burrows when approximately 10 - 12 days of age, beginning in May and early June. Beginning around 21 days of age, many young owls left their natal burrows and began to use satellite burrows within their parents' home range. The first satellite burrows used by owls in the 8 families that successfully fledged young were an average of 28.9 m from the natal burrow. Post-fledging dispersal, which we defined as permanent movements > 300 m away from the natal area, occurred between late-July and early October, when young owls were an average of 88 days old. Radio-tagged burrowing owls ($N = 15$) dispersed an average of 1.4 km from natal burrows prior to initiating fall migration, but this average is probably low because we lost track of several long distance dispersers. The mean dispersal direction was 153.8° ± 74.7°, but the movements were uniformly distributed in all directions. Siblings dispersed together (i.e., as a group) in some families, while in others they moved in different directions. Open grasslands were important habitats during both the pre-fledging and post-fledging periods. Burrowing owls increased their use of dense sagebrush habitat during the post-fledging and dispersal periods; this habitat was rarely occupied during the day during the pre-fledging period.

Fall migration appeared to be initiated during the period from mid-September through mid-October, although some individuals with which we lost contact may have migrated earlier. The last two radio-tagged owls (2 adult males) left the study area on 18 October. Thus, it appears that burrowing owls breeding in southwestern Idaho are migratory, and they leave the study area by mid-October. There is no information on where individuals from this breeding population spend the winter months.

Important mortality factors affecting both young and adults included predation by skunks (*Mephitis mephitis*) and other unidentified mammalian predators, shooting by humans, collisions with automobiles (road kills), entanglement with barbed wire fences, starvation, and cannibalism. During the pre-fledging period, juveniles experienced a survival rate of 77%, while only 1 of 26 adults failed to survive. During the post-fledging period, juveniles experienced a 92% survival rate, and no adults suffered mortality at this time.

INTRODUCTION

Burrowing owl (*Speotyto cunicularia*) populations are declining throughout much of their range (Haug et al. 1993). These declines have been attributed to control measures aimed at burrowing mammals, loss of habitat to cultivation and other land use activities, predation, and persecution by humans (Collins 1979, Rich 1986). Because of population declines, resource agencies in both the United States and Canada have listed burrowing owls among the species in need of management or special attention. Burrowing owls are listed as *endangered* in Manitoba, Iowa, and Minnesota, as *threatened* in Saskatchewan, Alberta, and British Columbia, and as a *species of special concern* in a number of western states (CA, MT, ND, OR, WA, WY) and in Florida. Idaho Fish and Game has not listed this species, but the U.S.D.I. Bureau of Land Management considers burrowing owls as a *sensitive* species in Idaho (Moseley and Groves 1992).

Several aspects of the biology of burrowing owls are well documented. These include burrowing owl food habits (e.g., Maser et al. 1971, Marti 1974, Gleason and Craig 1979, Schlatter et al. 1980, Brown et al. 1986, Green et al. 1993, Plumpton and Lutz 1993a) and nesting requirements (e.g., Gleason and Johnson 1985, MacCracken et al. 1985, Rich 1986, Green and Anthony 1989, Plumpton and Lutz 1993b). These studies indicate that burrowing owls require areas with short grass or shrubs, open sites, and the availability of below-ground burrows for nesting. Previous studies also indicate that burrowing owls feed on both vertebrate (mainly rodents) and invertebrate (mainly beetles) prey during the breeding season. In contrast, relatively little is known about the post-fledging behavior of burrowing owls (Haug et al. 1993). Because increasing recruitment of young into breeding populations may likely to be a major focus in reversing population declines, it is imperative that factors contributing to post-fledging behavior, dispersal, and survival of young burrowing owls be understood.

Our study was designed to monitor both young and adult burrowing owls to provide: (1) information on the post-fledging behavior of burrowing owls in southwestern Idaho, (2) an indication of the habitat variables important to burrowing owls during the post-fledging period, (3) an indication of the mortality factors operating during the nesting and post-fledging periods, and (4) information on the timing and distance of dispersal movements made by juvenile owls. Information from this study will hopefully be useful in formulating management strategies for this species throughout its range. This report summarizes our activities and data collected during the spring, summer, and fall of 1994.

METHODS

Study Area

We studied burrowing owls nesting singly and in loose colonies on federal (Bureau of Land Management) land near Kuna Butte, located approximately 3.2 km south of Kuna, in Ada County, Idaho (Fig. 1). The area is characterized by big sagebrush (*Artemisia tridentata*) shrubland, and grasslands dominated by cheatgrass brome (*Bromus tectorum*) in disturbed areas (Fig. 2a and 2b). Surrounding areas contain cultivated agricultural fields (primarily hay and wheat), scattered residential homes, and a large dairy farm. The topography of the area is flat to slightly rolling with a few isolated buttes and rock outcroppings.

Locating and Capturing Burrowing Owls

We searched suitable habitat for burrowing owls both on foot and from automobiles. Although many surveys were performed during late afternoon and early evening, we surveyed throughout all hours of the day and night. Frequently, we played a tape-recorded burrowing owl call (Haug and Didiuk 1993) over a loudspeaker (Johnny Stewart® Game & Animal Caller) to which owls responded with vocalizations. This helped identify the location of nesting owls. After locating owls, we monitored their nesting activities on a regular basis.

To capture owls we used bal-chatri traps, noose carpets or noose rods, Havahart® traps, Tomahawk® live traps, and Sherman® live traps placed at or near burrow entrances (Ferguson and Jorgensen 1981, Plumpton and Lutz 1992, Winchell and Turman 1992). Occasionally we placed bal-chatri traps within sight of roosting or hunting owls as we passed by in a vehicle. We also designed and constructed a trap that used a see-through, 1-way Plexiglas door placed within a PVC tube. The tube was inserted into burrow entrances. Young owls were able to leave their burrow through the 1-way door and were retained in a wire basket, but they were prevented from returning to the burrow by the door.

Upon capture, we recorded each owl's mass (to nearest 0.5 g), wing length, tarsus length, tail length, and length of exposed culmen (all to nearest 0.5 mm). We classified adult owls as females if they had well-developed brood patches. We were unable to discern gender of young owls based on appearance or morphological measurements. We fitted owls with a U.S. Fish and Wildlife Service aluminum leg band and three plastic, colored leg bands (National Band and Tag Co., Newport, KY) for future identification. Each owl included in the radio-telemetry study received a radio transmitter package (Wildlife Materials, Inc., Carbondale, IL), which was attached backpack style with woven nylon cord. Transmitters weighed 4 g and were designed to function for 4-5 months, which spanned both the post-fledging and dispersal periods.

Owl Monitoring

Radio-tagged and color-marked adults and juveniles were located daily using hand-held telemetry receivers and antennas. Each day we recorded the following variables concerning the diurnal locations of owls: habitat surrounding each owl's daytime roost (classified as open grassland, grasslands with sagebrush, dense sagebrush, rocky area, agricultural field, and roadway/fencerow), location of roost, type of perch, distance from natal burrow, distance from previous day's roost, distance between adults and young in a family group, and distance among young in a brood. We made these observations for the duration of the post-fledging period and up until the time when young dispersed from natal areas.

We located dispersing juveniles by searching near the natal area on foot using hand-held receivers and antennae. When ground searches did not locate dispersing juveniles, the study area was searched by a fixed-wing airplane equipped for radio-telemetry. After determining general locations of owls from the air, we determined specific locations of owls from the ground. We defined post-fledging dispersal as a permanent movement away from natal areas prior to fall migration. This typically coincided with a distance >300 m from the natal burrow. Thus, we considered a juvenile owl to have "dispersed" or left the natal area when it moved farther than 300 m from the natal burrow and did not return to the natal area.

Effects of Food Abundance on Post-fledging Dispersal Movements. — In conjunction with our radio-telemetry study, we conducted an experiment that varied the food availability for owls in some families. Two families of burrowing owls (identified as Dairy #2 and Kuna Butte #3) received supplemental feedings of mice and day-old chickens (≈ 111 g/family/day) to increase the amount of food to which they had access. Provisioning was intended as a supplement to, and not a substitute for, a normal diet. Our objective was to assess the prediction that supplemented juveniles will disperse sooner than those which are not supplementally fed. For example, if some juveniles are given a supply of "extra" food, they may grow and mature more quickly than those which are not supplementally fed. These juveniles could achieve independence at an earlier age and disperse from natal areas sooner. A contrasting prediction is that when juveniles have easy access to a reliable and sufficient food source there would be no urgent need to disperse from the natal area, and perhaps no need to disperse at all. Thus, supplemental food may instead delay post-fledging dispersal movements.

Nesting Habitat

Physical attributes of the nest burrow and surrounding vegetation were recorded for each burrowing owl nesting attempt on the study area. For each nest burrow we measured the diameter of the entrance, compass orientation of entrance, height of mound, distance to nearest burrow, distance to nearest occupied burrow, number of burrows within a 10 m radius, distance to first satellite burrow, vegetation height at burrow and within a 2 m radius, dominant plant species, vegetation type, distance to nearest perch, type of perch, height of perch, distance to nearest agricultural field, distance to nearest paved/gravel road, and the distance to the nearest source of water.

Data Analyses

We used analysis of variance (ANOVA) to compare habitat parameters at successful and unsuccessful nests using a Bonferonni correction for repeated one-way tests. We set our rejection level (i.e., α) at 0.05/12 = 0.004. Data derived from circular distributions (e.g., burrow entrance orientation, dispersal direction) were analyzed using circular statistics (Zar 1984). Mean angles (a) and angular deviation (s) were calculated for each sample, and a mean vector was plotted. The length of the mean vector (r) ranges from 0 - 1 and varies inversely with the amount of dispersion in the data. For example, r = 1.0 when all data are concentrated in the same direction, and r = 0 when there is so much dispersion that a mean angle cannot be described. We used Rayleigh's test to examine the null hypothesis that the population is uniformly distributed around the circle (i.e., in all directions). We compared mean angles between different groups using the Watson-Williams test (Zar 1984).

RESULTS

Trapping and Banding

Between 15 May and 14 August 1994, we captured 71 burrowing owls, including 7 adult males, 16 adult females and 48 juveniles. Appendix A contains band numbers, banding dates, color band combinations, radio transmitter frequencies, and age and sex information for owls captured during this study. Using a variety of methods (Table 1), owls were captured at or near 19 different nest burrows. Most nests were located on BLM land (Fig. 1). Most adult females were captured using Havahart® live traps while incubating eggs or brooding young. Adult males were more difficult to capture than females because they rarely entered nest burrows. The males that we did capture were caught using bal-chatri traps baited with a live mouse, noose rods, and Havahart® live traps. We captured many juveniles with noose rods and noose carpets buried at burrow entrances. As juvenile owls emerged from their burrows by walking along the entrance, they became entangled in the monofilament nooses extending from these traps. We also captured young owls (N = 8) by hand at entrances to burrows before the young could escape into burrows (Table 1).

Nest Site Habitat

We measured habitat parameters at 14 nests within the study area (summaries of habitat data sheets are provided in Appendix B). Burrowing owls nested in open areas, such as grasslands, with low vegetation. Vegetation at nest burrows averaged slightly more than 10 cm in height but increased to approximately 20 cm when averaged within a 2 m distance of nests (Table 2). Burrowing owls are thought to prefer low vegetation in the vicinity of their nests to facilitate detection of mammalian predators that could more easily approach nests in tall, dense vegetation. Most nests we studied were located in areas previously dominated by dense big sagebrush that had burned within the recent past (within 7 years). The area has subsequently converted into grasslands, dominated by cheatgrass brome and tumble mustards (*Sisymbrium* spp.), with a few big sagebrush trunks remaining. The vegetation around 10 nests (71.4%) was dominated by a mixture of cheatgrass brome and tumble mustards. The remaining four nests were surrounded by a mixture of cheatgrass brome, tumble mustards, and big sagebrush.

Nest burrows were characteristic of those dug by badgers (*Taxidea taxus*) and yellow-bellied marmots (*Marmota flaviventris*), and burrow availability within the study area appeared high enough that this factor would not limit reproduction by owls. Livestock manure was readily available because of the nearby dairy farm, and all nesting burrowing owls gathered manure to line the nest burrow or entrance. On average, active nests had another suitable burrow within 15 m, and there was an average of slightly over 4 additional burrows within a 10 m radius circle centered on nests burrows (Table 2). Table 3 illustrates the pairwise distances between 13 nests examined during 1994. The average orientation of burrow entrances was 93.9° ± 65.5° (mean ± angular deviation; r = 0.346) as illustrated in Fig. 3. We were unable to reject the null hypothesis that the population of burrow entrances is uniformly distributed around the circle (Rayleigh's $R = 4.84$, $z = 1.673$, $P > 0.10$). Thus, the sample of burrow entrances is not significantly oriented in a particular direction.

Burrowing owls used perches near their nests to scan for predators and prey, and to roost upon. Perches included metal fence posts, rock piles, dead sagebrush, a man-made shooting stand, manure piles, dirt berms, and wood fence posts. The nearest perch to each nest was an average of 13.4 m away, and perches averaged approximately 1 m in height (Table 2). Nests were typically close to (e.g., within 100 m) of agricultural fields (often used by owls for hunting prey), paved or gravel roads, and a source of water (Table 2).

Comparison of Habitat at Successful and Unsuccessful Burrows. — We defined successful nests as those that fledged at least one young owl. In 1994, eight nests successfully fledged young, while six were unsuccessful. To determine if nesting habitat affected reproductive success, we compared habitat parameters at successful and unsuccessful nests using separate univariate analyses of variance (ANOVA). Successful nests had lower vegetation both at the burrow entrance and within 2 m, but none of the univariate F-tests was significant (Table 4). Additionally, orientation of burrow entrances did not differ between the two groups (successful: 90.5° ± 60.7°, r = 0.440; unsuccessful 102.8° ± 71.4°, r = 0.223; Watson-Williams test: $F_{1,12} = 0.044$, $P > 0.50$; Fig. 3). However, before one can conclude with confidence that these and other habitat parameters did not affect reproductive success, a much larger study is required. Given the amount of variation in many of the parameters we examined, much larger sample sizes from longer term studies would be required to detect differences if in fact they occurred (i.e., to avoid type II statistical errors).

Breeding Season Behavior

We developed a chronology of breeding season activities based on our observations during the 1994 field season. Figure 4 indicates the timing of adult arrival, incubation of eggs, hatching, brooding, fledging, post-fledging dispersal, and fall migration. Below we review burrowing owl behavior during the pre-fledging and post-fledging periods, and provide an indication of the timing of fall migration based on observations of radio-tagged adults and juveniles.

Pre-fledging Behavior. — During the incubation and brooding periods (late-April to mid-June), adult male burrowing owls often remained close to nest burrows, either perched at the burrow entrance or on a nearby perch. Roosting males were vigilant, and they typically vocalized upon our approach. Males uttered their characteristic alarm call, at which time they flew to a nearby area to observe our activities around the nest burrow. Adult females typically remained in nest burrows either incubating or brooding young during the pre-fledging period. We observed adult males only rarely entering nest burrows. Males often left prey items at the burrow entrance, at which time adult females emerged and took the food items to their young within the burrow. Thus, our observations indicate that during the pre-fledging period adult males actively hunt and provide food for their mates and offspring. Adult males perched near the nest burrow and remained vigilant for potential predators and, via vocalizations, they perhaps communicated impending danger to females, who were frequently beneath the ground. Adult females appeared to incubate eggs without the assistance of their mates (only females developed brood patches), and females conducted the majority of the brooding of young.

Most juvenile burrowing owls hatched between mid-May and early-June (Fig. 4). The first young owls appeared above ground on 20 May. Based on morphological and feather development, we estimated that juveniles were typically around 10 - 12 days old when they appeared at burrow entrances for the first time. Juvenile burrowing owls at this age cannot fly. Juveniles owls began leaving the immediate vicinity of their natal burrows (i.e., entranceway and nearby mound) approximately 21 days after hatching. Because young at this stage were not capable of sustained flight, these first movements were probably accomplished by a combination of walking and flying to nearby *satellite* burrows. Satellite burrows are non-natal burrows used by owls for cover and roosting. The average distance from the natal burrow to the first satellite burrow was 28.9 m ($N = 8$ nests), ranging from around 7 m to over 50 m (Table 2). Most family groups had more than one satellite burrow within their respective natal areas that family members used on different occasions.

We classified the vegetation surrounding roosting owls each day upon which we located them. During the pre-fledging period, radio-tagged owls ($N = 15$) were observed in open grasslands 273 times (39.5%), grasslands with big sagebrush 183 times (26.5%), rock outcrops 141 times (20.4%), along roadsides or fencerows 78 times

(11.3%), in agricultural fields 11 times (1.6%), and in areas with dense big sagebrush 5 times (0.7%; Fig. 5).

Post-fledging Behavior. — Juveniles began flying (i.e., fledged) during the period between mid-June and mid-August (Fig. 4). The earliest that we observed young owls performing sustained flight was 14 June. Juveniles usually abandoned their natal burrows after fledging, but some returned for several days at a time subsequent to attaining the ability to fly.

After fledging, juveniles moved farther away from natal burrows but continued to occupy satellite burrows within their parents' home ranges. Siblings often remained together during this time. For example, three siblings, from the Swan Falls #1 family, roosted together at a burrow located 500 m from their natal burrow two days after departing from their natal area. However, juveniles in other families appeared to move independently of their siblings.

Our observations indicate that adult owls reduced or stopped providing juveniles with food prior to dispersal. In at least three family groups, adults left the nest area before their offspring. In two families, Dairy #2 and Kuna Butte #2, the adult males left several weeks prior the dispersal of their young. At Dairy #3, the adult female left the area before her offspring; the adult male remained in the natal area until mid-October (after the young dispersed) when it appeared to initiate fall migration.

Juveniles initiated post-fledging dispersal movements (>300 m) away from natal areas in late-July and continued into September (Table 5). The dispersal dates of 15 juveniles in 6 families ranged from 20 July - 2 October (mean date of dispersal was 19 August; Table 5). The mean age at the initiation of post-fledging dispersal movements was 88.1 days post-hatching. Dispersing juveniles traveled a mean distance of 1425.9 m from their natal burrows prior to the initiation of fall migration (Table 5). Figure 6 shows dispersal directions for 15 radio-tagged juvenile burrowing owls. The mean direction of dispersal was $153.8° \pm 74.7°$ ($r = 0.145$). The distribution of dispersal directions did not differ significantly from a uniform distribution (Rayleigh's $R = 2.235$, $z = 0.333$, $P > 0.50$); thus, dispersal directions appeared to be random rather than oriented in a specific direction.

After radio-tagged juveniles fledged, during the day they were observed in areas classified as grasslands with some big sagebrush ($N = 33$, 27.8%), open grasslands ($N = 30$, 25.2%), dense big sagebrush ($N = 28$, 23.5%), and rock outcrops ($N = 28$, 23.5%), respectively (Fig. 5). After fledging, we failed to observed the 15 young owls in agricultural fields or along roadsides and fencerows, at least during the day. Young owls were known to use these latter habitats at night, however (pers. observ.). Additionally, owls occupied dense sagebrush areas much more frequently during the post-fledging period than during the pre-fledging period (Fig. 5).

Effects of Food Abundance on Post-fledging Dispersal Movements. — Juvenile burrowing owls with access to supplemental food exhibited post-fledging dispersal movements later than those with no access to supplemental food (Table 6). Additionally, juveniles with no access to supplemental food moved much farther away from their natal areas than those receiving supplemental food. These results indicate that one factor influencing post-fledging movements in burrowing owls may be the availability of food during the post-fledging period.

Fall Migration

Table 7 summarizes the date of final sighting for juvenile radio-tagged burrowing owls ($N = 15$). It was difficult to discern when post-fledging movements ended and when fall migration movements began for many individuals. However, our observations suggest that many burrowing owls began migrating in mid-September. It was at this time that eight radio-tagged juveniles appeared to leave the study area because we were unable to relocate them, even from the fixed wing airplane during complete censuses of the study area. Prior to their sudden departure, we consistently observed these owls in the same locations for up to several weeks. That is, these owls clearly occupied specific areas after departure from the immediate vicinity of natal burrows. The last owls to leave the study area were two adult males, which remained until 18 October. On 19 October, we conducted our final aerial search of the study area and approximately 200 km^2 of adjacent habitat. We did not relocate any radio-tagged owls during this survey, and foot surveys after this time located no additional burrowing owls on the area. Based on results of earlier surveys during which we easily detected owls when they were present, had the young owls been in the vicinity, we are confident that we would have detected them during the aerial and foot surveys.

Mortality Factors and Survival Rates

Potential predators of burrowing owls were observed within the study area, including badgers, striped skunks (*Mephitis mephitis*), domestic cats (*Felis* sp.), coyotes (*Canis latrans*), several raptors, and several species of snakes. At least two of six unsuccessful nesting attempts failed because of predation. One of these failures was likely caused by a striped skunk which we observed leaving a nest burrow. The other was caused by an unknown predator that killed at least one nestling, and fatally wounded the adult female which we found dead at another burrow 30 m away. Juvenile owls also suffered mortality from shootings ($N = 1$), collisions with automobiles ($N = 1$), and entanglement in a barbed wire fence ($N = 1$). We also observed a prairie falcon (*Falco mexicanus*) attempt to capture juvenile owls which were standing at the entrance to their burrow. We suspect starvation contributed to the deaths of several nestlings in a family where at least eight young were present (Kuna Butte #6). One young owl (#1204-43616) was noticeably smaller than its siblings and appeared malnourished. On 5 June, this juvenile's leg bands (aluminum band and 3 color bands) were found within a regurgitated burrowing owl pellet at the entrance to the natal burrow. This juvenile was apparently eaten by a family member. We do not know if the juvenile was killed by a sibling or parent and then consumed, or if it died of starvation and was eaten later.

Nonetheless, there apparently was an insufficient supply of food for this large family so that it experienced brood reduction.

We calculated survival rates for both juveniles and adults during the pre-fledging and post-fledging periods. During the pre-fledging period, 27 of 35 young were known to survive (77% survival rate). Only 1 of 26 adults died during the pre-fledging period, giving rise to a 96.2% survival rate for adults during this time. Of the 27 young surviving the pre-fledging period, 25 survived to disperse (92% survival), while no adults died during the post-fledging period (100% survival).

SUMMARY AND CONCLUSIONS

Nest Habitat. — Burrowing owls in our study nested in areas with other burrows, close to roads and agricultural fields, and surrounded by bare ground, short grass, and sparse sagebrush. We found that nests that fledged at least one young had shorter vegetation surrounding them, but the difference only approached statistical significance. A larger study would be required to confirm the effect of vegetation height on reproductive success. Nonetheless, many of these parameters are similar to previously published accounts from other portions of the range of burrowing owls (e.g., Colorado, Plumpton and Lutz 1993b; Saskatchewan, Haug et al. 1993). In contrast, nests in Florida appear to be concentrated in residential and industrial areas (Haug et al. 1993). In a study designed to examine nest-site selection by burrowing owls in southcentral Idaho, Rich (1986) found that in comparison to randomly chosen sites, occupied sites (i.e., those used by nesting owls) had greater cover of cheatgrass brome, had a greater habitat diversity, were lower in elevation, and were more frequently on southerly aspects. According to Rich (1986), sagebrush was also a potentially important habitat feature because many nests were located within 100 m of sagebrush. As did Rich (1986), we found that continuous, dense sagebrush stands were rarely occupied by burrowing owls, at least during the nesting phase of the life cycle. Thus, in southwestern Idaho and throughout their range, burrowing owls use open areas with low vegetation for nesting, provided an adequate supply of burrows in which they can nest is available.

Behavior of Young Owls. — Young burrowing owls appeared at the entrances to their burrows before they were capable of sustained flight, and it was during this time period that we found it easiest to capture many of the young owls on the study area. Noose rods buried at the entrance to burrows were effective in capturing both young and adult owls at burrows. When owlets were around 21 days of age, they frequently left their natal burrows and took up residence at satellite burrows within the home ranges of their parents. The first satellite burrows used by young owls averaged slightly less than 30 m away from the natal burrow. Thus, it follows that if one observes young burrowing owls that are only marginally capable of flight, they are fairly close to the burrow in which they were raised. Young owls became capable of sustained flight beginning in mid-June, at which time they began to move farther away from natal burrows but remained within parental home ranges. It was more difficult to capture owls during this period, because they often flew from the burrow upon our approach with traps, rather than fleeing into the burrow, as did many younger owls. In addition, young owls after fledging used dense sagebrush habitat much more frequently than did owls prior to this time. This indicates that, although dense sagebrush habitat is rarely used by nesting owls, it may offer some characteristics that are desirable for dispersing owls and those preparing for fall migration. For example, this habitat may provide more cover from predators, more perches from which to scan for predators or potential prey, or more shade during the late summer when temperatures reach extremes.

Dispersal. — Young owls dispersed (made permanent movements of > 300 m from the natal burrow) beginning in July and when the juveniles were an average of 88 days old. These movements occurred throughout the period of late-July through late-September and early-October. Thus, if young burrowing owls are observed during this time period, one could not be certain that they were in the immediate vicinity of their natal burrows. That is, owls captured during this time period could not be considered *Locals* and, in the notation of the U.S. Fish and Wildlife Service's Bird Banding Laboratory, would best be aged as *Hatching Year*, with no connotation about them being raised in a particular study area. Haug (1985) suggested that young burrowing owls in Saskatchewan begin dispersing from breeding areas in late-July and early August, as the young owls become less dependent on parents. Although Haug's (1985) study did not monitor young with radio-telemetry, and therefore could not follow young as closely as we could, this suggests that similar behavior is observed in Canadian populations of burrowing owls.

We found that dispersing burrowing owls moved an average of 1.4 km from their natal burrows, ranging from around 200 m to over 3.6 km. This average value should be viewed with caution, however, because it comes largely from shorter distance dispersers (contact with owls that moved longer distances was occasionally lost). For example, we knew that juveniles from one family dispersed greater than 3 km because we did not locate them after repeated searches within this distance. We subsequently calculated their dispersal distance as > 3000 m (3 km), and included this value in our calculation of the average. Thus, the average dispersal distance would likely increase if the distances of birds moving farther were accurately known and included. Nonetheless, our data suggest that, on average, young burrowing owls do not move very far (usually less than 3 km) from their natal burrows before migrating in the fall. Our analyses also suggest that dispersal movements are not oriented in any particular direction; that is, dispersal movements were random in their orientation. This suggests that, despite the fact that they would be migrating south to winter for instance, owls did not consistently disperse in a southerly direction before initiating migratory movements.

Because our study was limited to one breeding season (1994), we do not have any information on how faithful breeding adults and their offspring are to breeding areas; that is, our study could not determine the degree to which burrowing owls in southwestern Idaho exhibit site fidelity. Additional field work during the spring and summer of 1995 would be required to assess the proportion of returning adults, and to determine if and how many young raised on the area in 1994 return to breed in 1995. Some site fidelity has been reported for adult burrowing owls in other portions of their range. In southern Saskatchewan, for instance, only 26% of re-encountered adults moved to different pastures, suggesting that many breeding adults returned to the same pasture to nest in subsequent years (Haug et al. 1993). In nonmigratory populations (e.g., Florida), as many as 68% of surviving adults remain faithful to nesting areas between years (Haug et al. 1993). Information on the breeding sites of returning juveniles is essentially lacking from the published literature. However, determining how faithful burrowing owls are to nesting sites has obvious wildlife and land management implications. That is, without this information, it would not be possible to adequately assess impacts to breeding sites that occur during the time period when owls are on their wintering areas. If owls show no fidelity, activities that disturb habitat in the immediate vicinity of burrows would have fewer negative impacts on the owls, because the owls would be unlikely to return to these sites anyway. However, if owls show strong fidelity to breeding sites, then negative impacts to these sites during winter could potentially be limited to avoid affecting this sensitive species.

The food supplementation experiment suggests that food availability may be one proximate factor that influences the dispersal movements of young owls, and this information may potentially have wildlife management implications as well. Although we only supplemented the diets of three young owls in two family groups, the data suggest that an adequate supply of food may cause young burrowing owls to delay dispersal movements. For example, we observed a large difference in the mean age at dispersal between the fed and unfed juveniles, with provisioned young dispersing an average of 48 days later. These results indicate that supplementally fed juveniles will disperse later than those which are not fed and that there may be no need to disperse when juveniles have easy access to a reliable food source. Such information could potentially be important if one were interested in manipulating the movements of burrowing owls. That is, one might be able to cause young owls to remain in their natal areas for an additional 6 weeks by providing a reliable food source (e.g., mice, chicks, etc.). By keeping young owls in the vicinity of natal areas, one could improve the chances that they do not move into areas where they would experience some known negative impact, for example. While it is difficult to imagine such a scenario presently, our results suggest that manipulating the availability of food during the post-fledging period is a tool that could be used by land managers to influence the movements and distributions of these and perhaps other birds.

Mortality Factors. — Six of the nests we monitored (43%) failed to fledge any young, and at least two of these failures were likely a result of predation by mammalian predators. We also documented several cases of mortality during both the pre-fledging and post-fledging periods. Important mortality factors during these periods included collisions with automobiles, shooting by humans, and predation. Although burrowing owls appear to be relatively tolerant of disturbance by humans, and they make use of many human-altered landscapes (e.g., roads, agricultural areas, residential areas), they also suffer because of a couple of factors directly or indirectly related to human activities. For example, Konrad and Gilmer (1984) reported that 3 of 5 known deaths in their study were caused by vehicle collisions, and Haug and Oliphant (1987; cited in Haug et al. 1993) concluded that 37% of owl remains they found were attributable to automobile collisions. With increasing human pressures in the immediate vicinity of our study area (i.e., Kuna and nearby Boise), it is likely that automobile collisions will become an increasingly important factor in affecting burrowing owl populations. However, because these owls often hunt and perch along roadways, there are probably few if any options available to limit the number of road kills in this area. In addition to our study, shooting by humans as a mortality factor has also been reported by Wedgwood (1978; cited in Haug et al. 1993) and Butts (1973), and Haug et al. (1993) conclude that the severity of this problem is unknown. However, it may be larger than we realize, particularly on public lands which allow all types of hunting and shooting activities. With proper education of shooters and enforcement of existing laws, this would appear to be one area in which mortality rates could be decreased if mortality from shooting increased to the point that it became a serious impact. Finally, predation by mammalian predators occurred on several occasions resulting in nest failure. If predation by mammals increased to the point that it began to cause population declines in our study area, at least one management option is available. For example, nest predation is so severe in some Canadian populations, where burrowing owls have declined rapidly in recent years, land managers are taking actions to repel nest predators (pers. comm., Dr. Joe Schmutz, member Canadian Burrowing Owl Recovery Team, University of Saskatchewan, Saskatoon). Wire guards are placed over the entrances to burrows, allowing owls to come and go, but they are constructed in such a way that they prohibit the much larger mammalian predators from entering and eating young. A much longer study of nest success and predation combined with longer-term population monitoring would be required to determine if burrowing owls in our study area are declining because of severe predation pressures or the other mortality factors we observed.

Migration. — While burrowing owls in Florida and southern California are nonmigratory (Thomsen 1971, Millsap *in press*, cited in Haug et al. 1993), our results indicate that both young and adult owls left our study area and surrounding locations by mid-October, and some individuals left much earlier. Although there is no information on where they winter, these initial data indicate that all of the burrowing owls in our study population migrated following the breeding season. Although this is consistent with the notion that burrowing owls in southwestern Idaho are obligate migrants, additional years of study would be required to determine if there is a facultative component to burrowing owl migration. For example, our one-year study could not address the possibility that these owls may fail to migrate in some years, or that some proportion of the population may remain in some years but not others. Furthermore, Haug et al. (1993) suggest the possibility that Canadian burrowing owls migrate farther south than those banded in the United States, suggesting a "leap-frog" migration, but considerable more work is needed in this area before we can understand the migratory patterns of burrowing owls.

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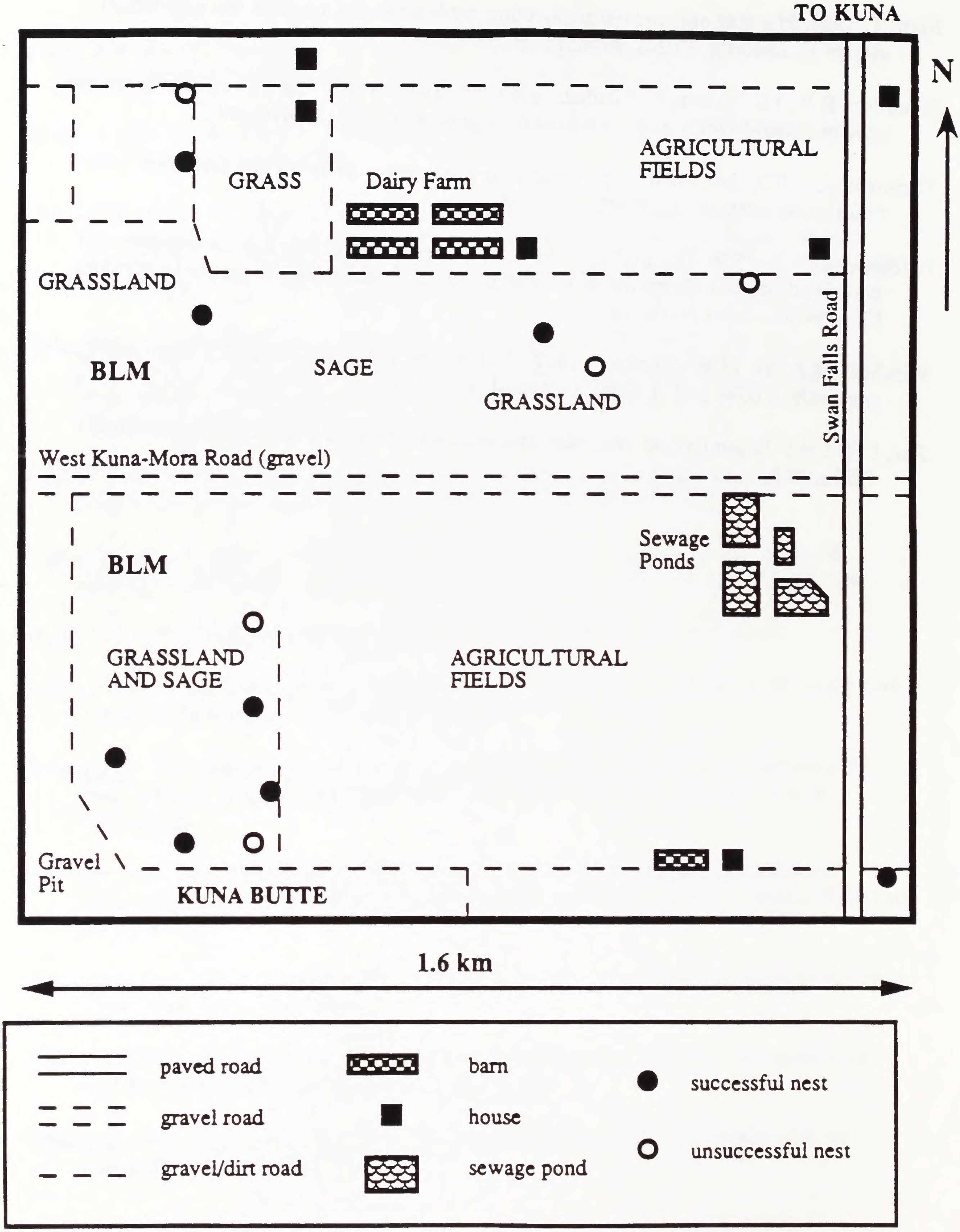

Figure 1. Graphical map of the study area located south of Kuna, Idaho, near Kuna Butte.

a)

b)

Figure 2. Photographs of the study area near Kuna, Ada County, Idaho. (a) This photo illustrates the open grassland habitats on the area. (b) A burrowing owl perches on a wooden fencepost near dense sagebrush habitat.

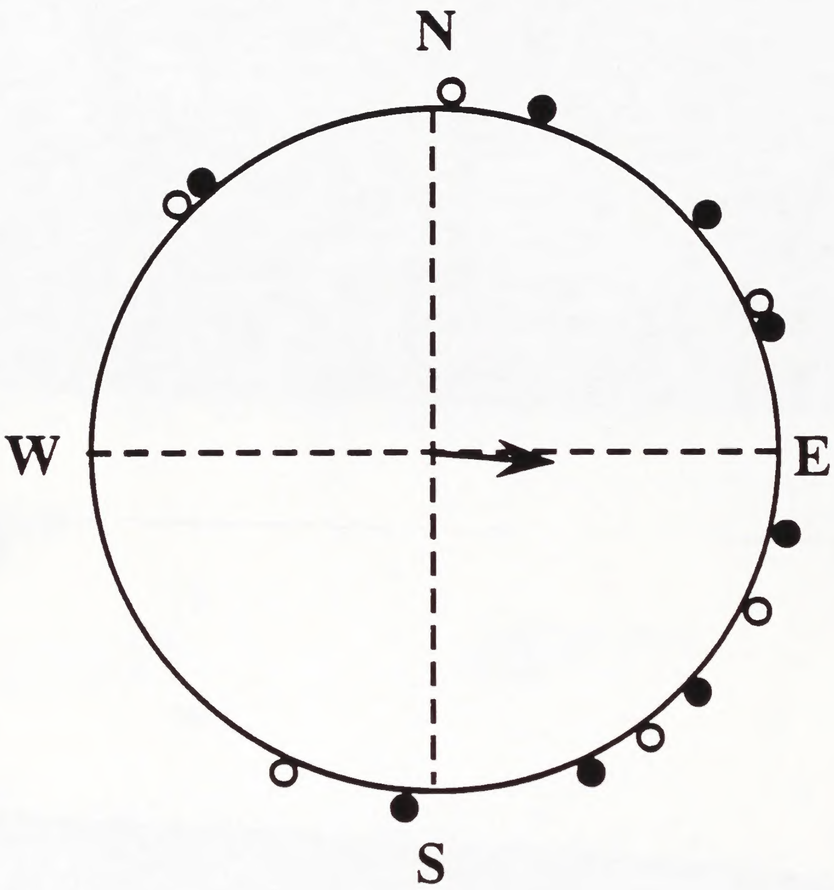

Figure 3. Circular scattergram of orientation of burrow entrances for successful (closed) and unsuccessful (open) burrowing owl nests during 1994. Mean orientation is signified by the arrow, which is 93.9°. The value of r varies from 0 - 1 (see text) and is indicated by the length of the arrow (0.346 in this case).

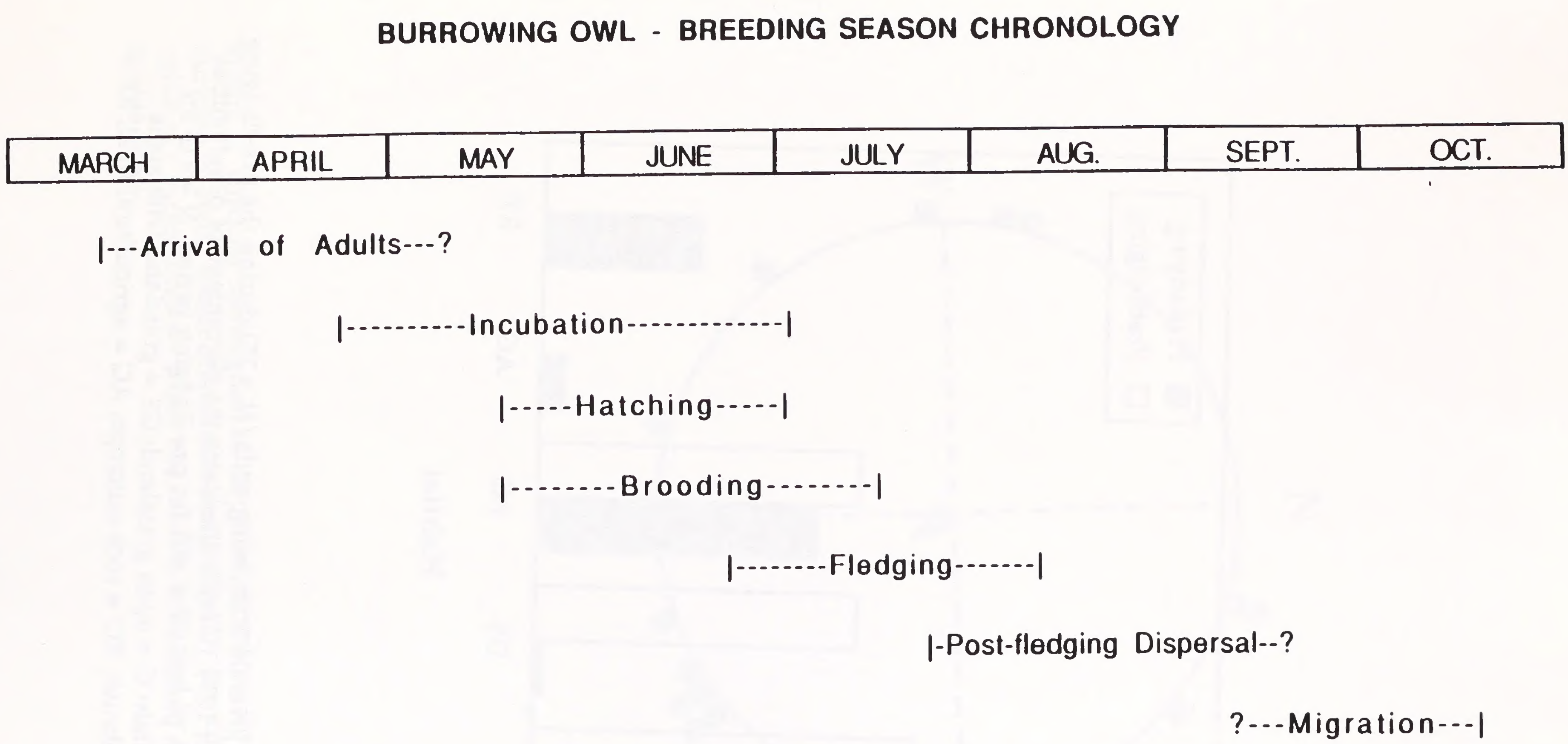

Figure 4. Chronology of events during the breeding season exhibited by burrowing owls in southwestern Idaho. Question marks reflect areas in which the timing of events remain uncertain.

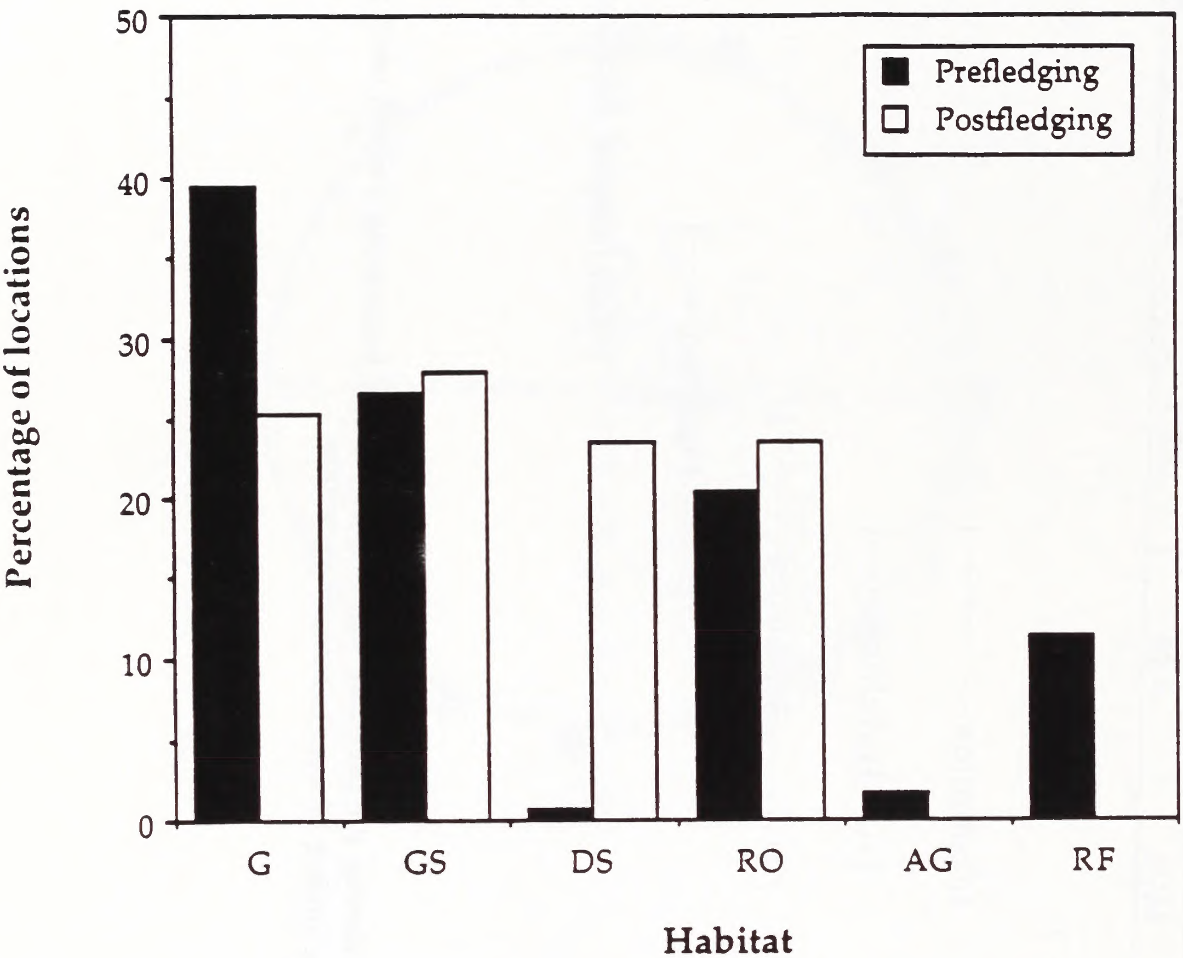

Figure 5. Habitats used by juvenile burrowing owls (N = 15) during the pre-fledging and post-fledging periods in 1994. Graph illustrates the percentage of observations in each habitat type for each period (N = 691 for pre-fledging period, N = 119 for post-fledging period). *Habitats*: G = open grassland; GS = grassland with some sagebrush; DS = dense sagebrush, RO = rock outcrops; AG = agricultural field; RF = roads/fencerows.

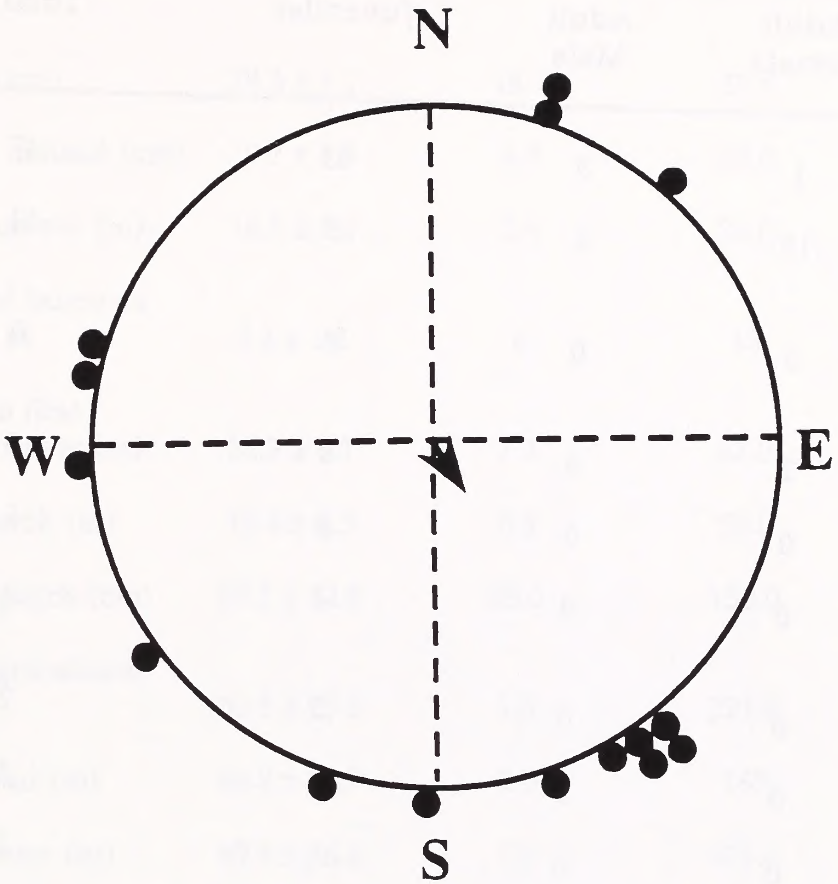

Figure 6. Circular scattergram of dispersal directions for 15 radio-tagged juvenile burrowing owls. Mean orientation is signified by the arrow, which is 153.8°. The value of r varies from 0 - 1 (see text) and is indicated by the length of the arrow (0.145 in this case).

Table 1. Summary of methods and captures of adult and juvenile burrowing owls during the 1994 field season. Totals differ from those in the text because some individuals were captured more than once. *Note:* all capture methods were not employed equally.

Method of Capture	Adult Female	Adult Male	Juveniles	Total
Noose rod	1	3	43	47
Havahart® live trap	15	1	5	21
Captured by hand	0	0	8	8
Bal-chatri	2	4	0	6
Noose carpet	0	0	5	5
Hand-made trap	0	0	4	4
Carrion trap	0	0	2	2
Noose rock	0	0	1	1
Sherman® live trap	0	0	1	1
Tomahawk® live trap	0	0	0	0
Total Captures	18	8	69	95

Table 2. Habitat characteristics at or near burrowing owl nest burrows in southwestern Idaho during 1994.

Variable	$\bar{x} \pm SE$	Minimum	Maximum	*N*
Burrow diameter (cm)	19.3 ± 1.1	15.0	27.5	14
Height of mound (cm)	10.7 ± 1.5	3.0	23.0	14
Nearest burrow (m)	14.4 ± 3.4	2.4	34.0	14
Number of burrows within 10 m	4.4 ± 1.2	0	13	14
Distance to first satellite burrow (m)	28.9 ± 6.1	7.3	57.0	8
Nearest perch (m)	13.4 ± 4.3	0.8	50.0	12
Height of perch (cm)	97.1 ± 12.9	25.0	150.0	12
Nearest agricultural field (m)	80.5 ± 25.3	1.0	321.0	14
Nearest road (m)	48.2 ± 12.7	0.5	163	14
Nearest water (m)	99.9 ± 26.4	1.0	321.0	14
Average ht. of veg. at burrow (cm)	11.1 ± 1.7	0	25.0	14
Average ht. of veg. within 2 m of burrow (cm)	21.1 ± 2.5	0	35.0	14

Table 3. Pairwise distances (m) between 13 burrowing owl nests examined during the 1994 breeding season. Comparisons with IBP #1 are excluded because this nest was located outside the main study area.

Location Name	D2	D3	D4	D5	D6	KB1	KB2	KB3	KB4	KB5	KB6	SF1
Dairy #1	491	1201	1237	461	1135	1545	1459	1355	1221	1614	1665	1238
Dairy #2		749	830	121	652	1296	1101	965	788	1250	1253	1338
Dairy #3			188	839	228	1318	1216	1045	815	1306	1194	1979
Dairy #4				935	412	1503	1398	1228	999	1494	1372	2109
Dairy #5					716	1142	1047	923	766	1199	1221	1220
Dairy #6						1087	983	814	592	1084	976	1784
Kuna Butte #1							101	274	508	104	305	1272
Kuna Butte #2								164	398	155	276	1265
Kuna Butte #3									222	290	317	1314
Kuna Butte #4										517	472	1398
Kuna Butte #5											216	1372
Kuna Butte #6												1550
Swan Falls #1												

Table 4. Comparison of habitat variables for successful ($N = 8$) and unsuccessful ($N = 6$) burrowing owl nests during 1994 based on univariate analyses using ANOVA.

Variable	Successful $\bar{x} \pm SE$	Unsuccessful $\bar{x} \pm SE$	F value	df	Probability
Entrance diameter (cm)	20.0 ± 1.7	18.3 ± 1.2	0.65	1,12	0.437
Height of mound (cm)	10.8 ± 1.7	10.6 ± 3.0	0.01	1,12	0.949
Nearest burrow (m)	15.7 ± 4.8	12.6 ± 5.0	0.19	1,12	0.671
Nearest occup. burrow (m)	237.5 ± 71.5	224.6 ± 70.1	0.01	1,11	0.906
No. burrows within 10 m	4.0 ± 1.5	5.6 ± 2.3	0.15	1,12	0.708
Nearest perch (m)	13.9 ± 6.3	12.8 ± 6.2	0.01	1,10	0.912
Height of perch (cm)	90.1 ± 15.0	107.0 ± 24.2	0.39	1,10	0.544
Nearest agricul. field (m)	100.6 ± 39.5	53.8 ± 27.0	0.82	1,12	0.382
Nearest road (m)	48.0 ± 14.3	48.3 ± 24.5	0.01	1,12	0.992
Nearest water (m)	128.7 ± 40.7	61.4 ± 24.9	1.67	1,12	0.221
Veg. height at burrow (cm)	9.4 ± 1.5	13.3 ± 3.33	1.39	1,12	0.261
Veg. height within 2 m of burrow (cm)	17.6 ± 3.0	25.8 ± 3.5	3.12	1,12	0.103

Table 5. Age at initiation of post-fledging dispersal movements and distance traveled by radio-tagged juveniles (N = 15) in 6 families of burrowing owls in southwestern Idaho in 1994.

Family	Number of Juveniles	Dispersal Age[a,b] ($\bar{x} \pm SE$)	Dispersal Age[b] Range (days)	Mean Dispersal Date	Dispersal Date Range	Max. Known Distance[c] (m) ($\bar{x} \pm SE$)
Dairy #2[d]	2	125.0 ± 9.0	116-134	23 Sept.	14 Sept. - 2 Oct.	208.5 ± 1.5
Dairy #3	3	69.7 ± 0.9	68-71	15 Aug.	11-17 Aug.	666.7 ± 167.7
Kuna Butte #2	4	89.3 ± 7.2	77-110	18 Aug.	6 Aug. - 8 Sept.	841.8 ± 258.7
Kuna Butte #3[d]	1	116.0 ± 0.00	116	18 Sept.	18 Sept.	195.0
Kuna Butte #6	2	70.5 ± 3.5	67-74	22 July	20-24 July	3000.0 ± 0.00
Swan Falls #1	3	58.0 ± 0.00	58	22 July	22 July	3643 ± 2522.5
All Families	15	88.1 ± 11.1	58-134	19 Aug.	20 July - 2 Oct.	1425.9 ± 614.0

[a] A juvenile was considered to have dispersed when it made a permanent movement >300 m away from its natal burrow.
[b] The number of days post-hatching estimated by morphological characteristics at the time of capture.
[c] The farthest distance a juvenile was observed away from its natal burrow (during the day-time) prior to fall migration.
[d] These 2 families were provided with supplemental food (dead chicks and mice) throughout the breeding season (May - Sept.).

Table 6. Comparison of the timing and distance of post-fledging dispersal movements made by juvenile burrowing owls with and without access to supplemental food (mice and day-old chickens) during the breeding season.

Treatment	N	Dispersal Age[a,b] ($\bar{x} \pm SE$)	Dispersal Age[b] Range (days)	Mean Dispersal Date	Dispersal Date Range	Maximum Distance[c] (m) ($\bar{x} \pm SE$)
Access to supplemental food	3	120.5 ± 4.5	116-134	20 Sept.	14 Sept. - 2 Oct.	201.8 ± 6.8
No access to supplemental food	12	71.8 ± 6.5	58-110	3 Aug.	20 July - 8 Sept.	2037.9 ± 753.6

[a] A juvenile was considered to have dispersed when it made a permanent movement >300 m away from its natal burrow.
[b] The number of days post-hatching estimated by morphological characteristics at the time of capture.
[c] The farthest distance a juvenile was observed away from its natal burrrow (during the day-time) prior to fall migration.

Table 7. Timing of final sighting and presumed fates of 15 radio-tagged juvenile burrowing owls during fall 1994.

Family	Owl #	Final Sighting	Presumed Fate
Dairy #2	33	2 October	Migrated
	34	14 September	Migrated
Dairy #3	61	14 September	Migrated
	64	15 September	Migrated
	66	12 September	Migrated
Kuna Butte #2	31	8 September	Migrated
	32	5 September	Dead
	46	21 August	Unknown
Kuna Butte #3	38	18 September	Migrated
Kuna Butted #6	21	24 July	Unknown
	22	20 July	Unknown
Swan Falls #1	60	17 August	Unknown
	62	17 August	Dead (shot)
	65	12 September	Migrated

APPENDIX A:
Banding Data

Band numbers, color-marking on right and left legs, and radio-transmitter frequencies for burrowing owls marked during 1994 on our study area located approximately 4 km south of Kuna, Ada County, Idaho.

Band Number	Date	Age	Sex	Right	Left	Radio (MHz)
1204-43601	15 May	AHY	M	R,AL	R,R	
1204-43602	15 May	AHY	M	R,AL	R,B	151.870
1204-43603	17 May	AHY	F	R,AL	R,G	
1204-43604	17 May	AHY	F	R,AL	R,Y	
1204-43605	18 May	AHY	F	R,AL	R,W	
1204-43606	18 May	AHY	F	R,AL	R,P	
1204-43607	19 May	AHY	F	R,AL	B,R	151.336
1204-43608	19 May	AHY	F	R,AL	B,B	151.306
1204-43609	19 May	AHY	M	R,AL	B,G	151.355
1204-43610	20 May	AHY	F	R,AL	B,Y	151.790
1204-43611	20 May	AHY	M	R,AL	B,W	151.852
1204-43612	22 May	AHY	F	R,AL	B,P	
1204-43613	22 May	AHY	F	R,AL	G,R	151.721
1204-43614	24 May	AHY	F	R,AL	G,B	
1204-43615	24 May	AHY	F	R,AL	G,G	
1204-43616	24 May	L	U	R,AL	G,Y	
1204-43617	24 May	L	U	R,AL	G,W	
1204-43618	24 May	AHY	F	R,AL	G,P	
1204-43619	24 May	L	U	R,AL	Y,R	
1204-43620	26 May	AHY	F	R,AL	Y,B	
1204-43621	28 May	L	U	R,AL	Y,G	151.346
1204-43622	28 May	L	U	R,AL	Y,Y	151.841
1204-43623	31 May	AHY	F	R,AL	Y,W	
1204-43624	31 May	L	U	R,AL	Y,P	
1204-43625	1 June	AHY	F	R,AL	P,R	
1204-43626	1 June	L	U	R,AL	P,B	
1204-43627	1 June	L	U	R,AL	P,G	151.316
1204-43628	1 June	L	U	R,AL	P,Y	
1204-43629	2 June	L	U	R,AL	P,W	151.762
1204-43630	2 June	AHY	M	R,AL	P,P	
1204-43631	2 June	L	U	R,AL	W,R	151.860
1204-43632	2 June	L	U	R,AL	W,B	151.742
1204-43633	3 June	L	U	R,AL	W,G	151.880
1204-43634	3 June	L	U	R,AL	W,Y	151.771
1204-43635	6 June	L	U	R,AL	W,W	
1204-43636	7 June	L	U	R,AL	W,P	

Band Number	Date	Age	Sex	Right	Left	Radio (MHz)
1204-43637	8 June	AHY	M	B,AL	R,R	
1204-43638	8 June	L	U	B,AL	R,B	151.731
1204-43639	8 June	L	U	B,AL	R,G	
1204-43640	8 June	L	U	B,AL	R,Y	
1204-43641	8 June	L	U	B,AL	R,W	
1204-43642	8 June	L	U	B,AL	R,P	
1204-43643	8 June	L	U	B,AL	B,R	151.870
1204-43644	9 June	AHY	F	B,AL	B,B	
1204-43645	10 June	L	U	B,AL	B,G	151.327
1204-43646	10 June	L	U	B,AL	B,Y	151.830
1204-43647	13 June	AHY	M	B,AL	B,W	151.819
1204-43648	18 June	L	U	B,AL	B,P	151.711
1204-43649	18 June	L	U	B,AL	G,R	151.810
1204-43650	26 June	L	U	B,AL	G,B	
1204-43651	28 June	L	U	B,AL	G,G	
1204-43652	28 June	L	U	B,AL	G,Y	
1204-43653	29 June	L	U	B,AL	G,W	
1204-43654	29 June	L	U	B,AL	G,P	
1204-43655	29 June	L	U	B,AL	Y,R	
1204-43656	29 June	L	U	B,AL	Y,B	
1204-43657	29 June	L	U	B,AL	Y,G	
1204-43658	29 June	L	U	B,AL	Y,Y	
1204-43659	11 July	L	U	B,AL	Y,W	151.751
1204-43660	13 July	L	U	B,AL	Y,P	151.781
1204-43661	17 July	L	U	B,AL	W,R	151.802
1204-43662	18 July	L	U	B,AL	W,B	151.721
1204-43663	18 July	L	U	B,AL	W,G	151.711
1204-43664	20 July	L	U	B,AL	W,Y	151.316
1204-43665	21 July	L	U	B,AL	W,W	151.762
1204-43666	21 July	L	U	B,AL	W,P	151.810
1204-43667	31 July	L	U	B,AL	P,R	
1204-43668	31 July	L	U	B,AL	P,B	
1204-43669	1 August	L	U	B,AL	P,G	
1204-43670	1 August	L	U	B,AL	P,Y	
1204-43671	14 August	HY	U	B,AL	P,W	

Age: AHY = after hatching year; L = local; HY = hatching year
Sex: M = male; F = female; U = unknown
Color band: AL = aluminum; R = red; B = blue; G = green;
Y = yellow; W = white; P = pink

APPENDIX B:
Nest Habitat Data

NESTING HABITAT CHARACTERISTICS

Date: 6 June 1994
Location Name: **DAIRY #1** **(UNSUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 16.0 cm
Height of mound: 3.0 cm
Compass direction of entrance: 2°
Distance to nearest burrow: 34.0 m
Distance to nearest occupied burrow: 491 m
Number of burrows within 10 m radius: 0
Distance to first satellite burrow: N/A
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 15.0 cm
Average height within 2 m radius: 25.0 cm
Dominant plant species: *Bromus tectorum*
Vegetation type: a weedy fencerow bordered by a gravel road, a disturbed grassland and an alfalfa field

OTHER MEASUREMENTS

Distance to nearest perch: 1.0 m
Perch type: metal fencepost
Height of perch: 150.0 cm
Distance to nearest cultivated field: 9.0 m
Distance to nearest paved/gravel road: 0.7 m
Distance to nearest source of water: 8.0 m (irrigation ditch)

NESTING HABITAT CHARACTERISTICS

Date: 21 June 1994
Location name: **DAIRY #2 (SUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 23.0 cm
Height of mound: 10.0 cm
Compass direction of entrance: 319°
Distance to nearest burrow: 3.35 m
Distance to nearest occupied burrow: 120.7 m
Number of burrows within 10 m radius: 8
Distance to first satellite burrow: 45.5 m
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 15.0 cm
Average height within 2 m radius: 30.0 cm
Dominant plant species: *Bromus tectorum, Artemisia tridentata, Sisymbrium* spp.
Vegetation type: disturbed grassland

OTHER MEASUREMENTS

Distance to nearest perch: 3.65 m
Perch type: dead sagebrush (killed by fire)
Height of perch: 80.0 cm
Distance to nearest cultivated field: 105 m
Distance to nearest paved/gravel road: 83 m
Distance to nearest source of water: 103 m (irrigation ditch)

NESTING HABITAT CHARACTERISTICS

Date: 21 June 1994
Location name: DAIRY #3 (SUCCESSFUL)

BURROW MEASUREMENTS

Diameter of entrance: 25.5 cm
Height of mound: 5.0 cm
Compass direction of entrance: 71°
Distance to nearest burrow: 30.0 m
Distance to nearest occupied burrow: 188.0 m
Number of burrows within 10 m radius: 0
Distance to first satellite burrow: 30.0 m
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 0.0 cm
Average height within 2 m radius: 0.0 cm
Dominant plant species: none
Vegetation type: mostly disturbed bare soil

OTHER MEASUREMENTS

Distance to nearest perch: 12.3 m
Perch type: gun shooting stand
Height of perch: 110.0 cm
Distance to nearest cultivated field: 1.0 m
Distance to nearest paved/gravel road: 0.5 m
Distance to nearest source of water: 247 m (irrigation ditch)

NESTING HABITAT CHARACTERISTICS

Date: 21 June 1994
Location name: **DAIRY #4 (UNSUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 22.0 cm
Height of mound: 5.0 cm
Compass direction of entrance: 68°
Distance to nearest burrow: 21.0 m
Distance to nearest occupied burrow: 188.0 m
Number of burrows within 10 m radius: 0
Distance to first satellite burrow: N/A
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 0.0 cm
Average height within 2 m radius: 10.0 cm
Dominant plant species: none
Vegetation type: mostly disturbed bare soil

OTHER MEASUREMENTS

Distance to nearest perch: N/A
Perch type: N/A
Height of perch: N/A
Distance to nearest cultivated field: 1.0 m
Distance to nearest paved/gravel road: 0.5 m
Distance to nearest source of water: 59.0 m (irrigation ditch)

NESTING HABITAT CHARACTERISTICS

Date: 21 June 1994
Location name: **DAIRY #5 (UNSUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 19.0 cm
Height of mound: 10.0 cm
Compass direction of entrance: 198°
Distance to nearest burrow: 5.8 m
Distance to nearest occupied burrow: 120.7 m
Number of burrows within 10 m radius: 11
Distance to first satellite burrow: N/A
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 15.0 cm
Average height within 2 m radius: 30.0 cm
Dominant plant species: *Bromus tectorum, Sisymbrium* spp., *Artemisia tridentata*
Vegetation type: disturbed grassland

OTHER MEASUREMENTS

Distance to nearest perch: 8.9 m
Perch type: dead sagebrush (killed by fire)
Height of perch: 80.0 cm
Distance to nearest cultivated field: 183 m
Distance to nearest paved/gravel road: 163 m
Distance to nearest source of water: 181 m (irrigation ditch)

NESTING HABITAT CHARACTERISTICS

Date: 10 June 1994
Location name: **DAIRY #6 (SUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 15.5 cm
Height of mound: 15.0 cm
Compass direction of entrance: 120°
Distance to nearest burrow: 28.4 m
Distance to nearest occupied burrow: 228 m
Number of burrows within 10 m radius: 0
Distance to first satellite burrow: 57.0 m
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 10.0 cm
Average height within 2 m radius: 23.0 cm
Dominant plant species: *Bromus tectorum, Sisymbrium* spp., *Artemisia tridentata*
Vegetation type: disturbed grassland bordering dense sagebrush

OTHER MEASUREMENTS

Distance to nearest perch: N/A
Perch type: dead sagebrush (killed by fire)
Height of perch: N/A
Distance of nearest cultivated field: 169 m
Distance to nearest paved/grave/ road: 62 m
Distance to nearest source of water: 160 m (irrigation ditch)

NESTING HABITAT CHARACTERISTICS

Date: 16 June 1994
Location name: **KUNA BUTTE #1 (UNSUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 16.5 cm
Height of mound: 23.0 cm
Compass direction of entrance: 143°
Distance to nearest burrow: 6.5 m
Distance to nearest occupied burrow: 101.2 m
Number of burrows within 10 m radius: 13
Distance to first satellite burrow: N/A
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 10.0 cm
Average height within 2 m radius: 35.0 cm
Dominant plant species: *Bromus tectorum, Sisymbrium* spp.
Vegetation type: grassland

OTHER MEASUREMENTS

Distance to nearest perch: 20 m
Perch type: large manure pile
Height of perch: 130 cm
Distance to nearest cultivated field: 51.0 m
Distance to nearest paved/gravel road: 46.3 m
Distance to nearest source of water: 46.3 m (puddles from irrig.)

NESTING HABITAT CHARACTERISTICS

Date: 16 June 1994
Location name: **KUNA BUTTE #2 (SUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 15.9 cm
Height of mound: 5.0 cm
Compass direction of entrance: 182°
Distance to nearest burrow: 21.4 m
Distance to nearest occupied burrow: 101.2 m
Number of burrows within 10 m radius: 1
Distance to first satellite burrow: 18.0 m
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 10.0 cm
Average height within 2 m radius: 20.0 cm
Dominant plant species: *Bromus tectorum, Sisymbrium* spp.
Vegetation type: grassland

OTHER MEASUREMENTS

Distance to nearest perch: 15.9 m
Perch type: metal fencepost
Height of perch: 145.5 cm
Distance to nearest cultivated field: 51.0 m
Distance to nearest paved/gravel road: 11.0 m
Distance to nearest source of water: 11.0 m (puddles from irrig.)

NESTING HABITAT CHARACTERISTICS

Date: 16 June 1994
Location name: KUNA BUTTE #3 (SUCCESSFUL)

BURROW MEASUREMENTS

Diameter of entrance: 21.0 cm
Height of mound: 12.5 cm
Compass direction of entrance: 47°
Distance to nearest burrow: 4.0 m
Distance to nearest occupied burrow: 222.0 m
Number of burrows within 10 m radius: 6
Distance to first satellite burrow: 7.3 m
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 12.0 cm
Average height within 2 m radius: 20.0 cm
Dominant plant species: *Bromus tectorum, Sisymbrium* spp.
Vegetation type: grassland

OTHER MEASUREMENTS

Distance to nearest perch: 5.5 m
Perch type: large rock
Height of perch: 35.0 cm
Distance to nearest cultivated field: 36.0 m
Distance to nearest paved/gravel road: 31.3 m
Distance to nearest source of water: 31.3 m (puddles from irrig.)

NESTING HABITAT CHARACTERISTICS

Date: 16 June 1994
Location name: **KUNA BUTTE #4 (UNSUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 21.0 cm
Height of mound: 7.6 cm
Compass direction of entrance: 126°
Distance to nearest burrow: 3.7 m
Distance to nearest occupied burrow: 222.0 m
Number of burrows within 10 m radius: 3
Distance to first satellite burrow: N/A
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 15.0 cm
Average height within 2 m radius: 30.0 cm
Dominant plant species: *Bromus tectorum, Sisymbrium* spp., *Artemisia tridentata*
Vegetation type: grassland with scattered sagebrush

OTHER MEASUREMENTS

Distance to nearest perch: 0.8 m
Perch type: rock
Height of perch: 25.0 cm
Distance to nearest cultivated field: 37.0 m
Distance to nearest paved/grave/ road: 32.0 m
Distance to nearest source of water: 32.0 m (puddles from irrig.)

NESTING HABITAT CHARACTERISTICS

Date: 17 June 1994
Location name: **KUNA BUTTE #5 (SUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 16.0 cm
Height of mound: 15.0 cm
Compass direction of entrance: 108°
Distance to nearest burrow: 5.3 m
Distance to nearest occupied burrow: 104.0 m
Number of burrows within 10 m radius: 7
Distance to first satellite burrow: 10.3 m
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 10.0 cm
Average height within 2 m radius: 18.0 cm
Dominant plant species: *Bromus tectorum, Sisymbrium* spp.
Vegetation type: grassland

OTHER MEASUREMENTS

Distance to nearest perch: 8.2 m
Perch type: dead sagebrush (killed by fire)
Height of perch: 70.0 cm
Distance to nearest cultivated field: 155.0 m
Distance to nearest paved/gravel road: 95.0 m
Distance to nearest source of water: 155.0 m (puddles from irrig.)

NESTING HABITAT CHARACTERISTICS

Date: 17 June 1994
Location name: **KUNA BUTTE #6 (SUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 27.5 cm
Height of mound: 17.0 cm
Compass direction of entrance: 158°
Distance to nearest burrow: 2.4 m
Distance to nearest occupied burrow: 216 m
Number of burrows within 10 m radius: 10
Distance to first satellite burrow: 25 m
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 10.0 cm
Average height within 2 m radius: 15.0 cm
Dominant plant species: *Bromus tectorum, Sisymbrium* spp.
Vegetation type: grassland

OTHER MEASUREMENTS

Distance to nearest perch: 50 m
Perch type: dirt berm
Height of perch: 60.0 cm
Distance to nearest cultivated field: 321 m
Distance to nearest paved/gravel road: 95 m
Distance to nearest source of water: 321 m (puddles from irrig.)

NESTING HABITAT CHARACTERISTICS

Date: 17 August 1994
Location name: **SWAN FALLS #1 (SUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 16.0 cm
Height of mound: 7.0 cm
Compass direction of entrance: 20°
Distance to nearest burrow: 34.0 m
Distance to nearest occupied burrow: 720 m
Number of burrows within 10 m radius: 0
Distance to first satellite burrow: 38 m
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 8.0 cm
Average height within 2 m radius: 15.0 cm
Dominant plant species: *Bromus tectorum, Sisymbrium* spp.
Vegetation type: fencerow (burned), grassland, sugarbeet field

OTHER MEASUREMENTS

Distance to nearest perch: 1.5 m
Perch type: metal fencepost
Height of perch: 130.0 cm
Distance to nearest cultivated field: 1.0 m
Distance to nearest paved/gravel road: 6.5 m
Distance to nearest source of water: 1.0 m (puddles from irrig.)

NESTING HABITAT CHARACTERISTICS

Date: 29 June 1994
Location name: **IBP #1** **(UNSUCCESSFUL)**

BURROW MEASUREMENTS

Diameter of entrance: 15.0 cm
Height of mound: 15.0 cm
Compass direction of entrance: 311°
Distance to nearest burrow: 4.7 m
Distance to nearest occupied burrow: N/A
Number of burrows within 10 m radius: 3
Distance to first satellite burrow: N/A
Livestock manure at burrow entrance: YES

VEGETATION

Average height at burrow: 25.0 cm
Average height within 2 m radius: 25.0 cm
Dominant plant species: *Bromus tectorum, Sisymbrium* spp.
Vegetation type: pastureland/grassland

OTHER MEASUREMENTS

Distance to nearest perch: 33.4 m
Perch type: wood fencepost
Height of perch: 150.0 cm
Distance to nearest cultivated field: 42.0 m
Distance to nearest paved/gravel road: 47.4 m
Distance to nearest source of water: 47.4 m (puddles from irrig.)

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